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INTERNATIONAL APPLICATION PUBLISHED UNDER ... WO 9605552A1

(51) International Patent Classification 6 : G06F 7/04

A1

(11) International Publication Number: WO 96/05552

(43) International Publication Date: 22 February 1996 (22.02.96)

(21) International Application Number: PCT/US95/10315

(22) International Filing Date: 14 August 1995 (14.08.95)

(30) Priority Data:
08/289,780 12 August 1994 (12.08.94) US

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(81) Designated States: AU, CA, CN, FI, GE, JP, NO, PL, RU, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

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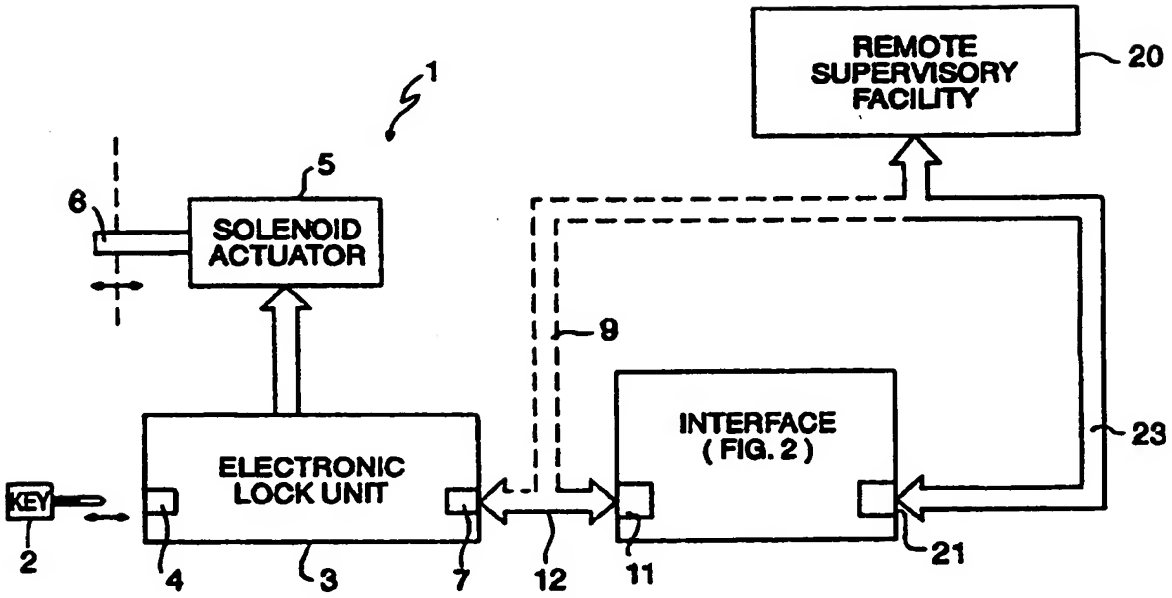
(54) Title: INTERFACE BETWEEN ELECTRONIC LOCK AND REMOTE SITE



(57) Abstract

An interface (fig. 2) between an electronic key (2) and lock (3) of an electronic key system (1) and a remote supervisory control device (20), such as a central security station of an office building, hotel and similar multi-entry way facilities, is configured to also provide autonomous control of one or more auxiliary input/output devices, such as a surveillance camera, fire alarm and the like. In order to communicate with the lock unit, the interface includes a first communications port (11) which is coupled to the internal controller of the lock unit (3). Similarly, a second communication port (21) provides communications capability with the supervisory control processor at the central control station (20). An interface control processor is coupled to each of the first and second communications ports, and is operative to exchange messages with a controller contained in the lock unit (3) and a supervisory processor in the remote site (20).

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INTERFACE BETWEEN ELECTRONIC LOCK AND REMOTE SITE

FIELD OF THE INVENTION

The present invention relates in general to electronic lock and key systems, and is particularly directed to an interface unit, which is configured to operate as a stand alone interface unit, so that it may provide a communication path between an electronic lock and a remote supervisory control device, such as a central security station of an office building, hotel and similar multi-entry way facility, and also provide autonomous control of the electronic lock and one or more auxiliary input/output devices, such as a surveillance camera, fire alarm and the like.

BACKGROUND OF THE INVENTION

Co-pending U.S. Patent Application Serial No. 174,036 (hereinafter referred to as the '036 application), filed Dec. 28, 1993, by Christopher Malinowski et al, entitled "Electronic Lock and Key System," assigned to the assignee of the present application and the disclosure of which is herein incorporated, describes an electronic lock and key system, in which each of a key and a lock unit, which is engaged by and communicates with the key and operates an actuator device (e.g. solenoid that translates a dead bolt element between lock and open positions), contains on-board intelligence and associated memory that allows the respective micro-controllers within the lock unit and the key to be individually programmed.

The lock unit has its own internal power supply (battery), which supplies electrical power to both the lock unit and a key that is engaged with the lock unit, so that for each access site where such a lock unit is installed, the lock unit may be operated as an essentially self-contained, stand alone system, that possesses all the functionality necessary to provide controlled entry to that access site. Because the lock unit's key interface provides two way (infrared) communications with a key, the key interface may be used to couple a lock interrogation and programming device with the lock unit, so that interrogation and provisioning messages may be exchanged with the lock's internal control processor.

In addition, the lock unit has an auxiliary programmable input/output port, providing a programmable input and output pathway that allows the lock to communicate with a central database by, for example, a telephone line. In this manner the lock unit may be remotely provisioned (controlled and reprogrammed with information received from the central database), as well as send information to the database. The central database can therefore maintain accurate and up-to-date records of the identity and accessing of multiple lock units that have been installed at a plurality of access locations, such as a plurality of perimeter doors of a building.

Now although the ability to remotely monitor and supervise the operation of a plurality of lock units enhances the security of a building in which such a system is installed, maintaining such an active communication link on a full time basis would place a substantial overhead burden on the supervisory site. On the other hand, since the degree of supervision required from the central security station is not necessarily a constant (for example, during normal daytime business hours, access to the main entry and exit doors of a building may be generally permitted to all members of the public, whereas, after the close of business hours, access may be restricted), the need for interaction between the security station and such entry points should be tailored to times when it is most needed, thereby reducing the amount of communications and information processing overhead borne by the central security station's supervisory processor. Such tailoring of interaction between the supervisory station and the lock is underscored by the fact that most of the events involving the security system happen at the location of the lock. As a result, should there be a failure involving the supervisory site or the link between the lock and the site, the ability of the lock to perform its intended function must not be degraded.

SUMMARY OF THE INVENTION

To satisfy this objective, the present invention provides a new and improved electronic lock interface, which enables a remote control facility to communicate with (including interrogating and provisioning) the lock, as necessary, while still allowing the lock to function as a stand alone device. The inventive interface also provides for the execution of one or more auxiliary functions (which may be either in conjunction with or exclusive of the operation of the lock) in association with the site at which the lock is located. Examples of auxiliary functions that may be employed in conjunction with the operation of the lock include, but are not limited to, the operation of an input or output device such as a surveillance camera or alarm. A non-limiting example of an auxiliary function exclusive of the operation of the lock is the operation of a zone sprinkler in the vicinity of the lock interface. The input/output devices which execute the respective auxiliary functions are exclusive of the interface and are coupled to the interface by means of respective switching elements, the states of which are either controlled by the interface (in the case of an output device, such as an alarm or surveillance camera) or which are applied as inputs, such as may be supplied by a heat sensing fire alarm device.

To this end, the interface includes a first communications port, which is coupled to the internal microcontroller of an electronic lock unit. Such an electronic lock unit is preferably of the type described in the above-referenced '036 application, having an auxiliary input/output port for exchanging communications with a remote supervisory device. When coupled to the interface of the invention, the electronic lock uses this port to communicate with the interface, rather than directly to the remote database. The interface, in turn, communicates with the remote supervisory site.

The interface includes a second communications port, which is preferably coupled to a digital communications transceiver (UART), through which the interface communicates with the remote site. The transceiver is also preferably coupled with a stereo phone jack to allow for acoustic tone (e.g. DTMF) signalling with an external modem. The internal intelligence of the interface comprises an interface control processor, which is coupled to each of the first and second communications ports, and which is operative to exchange messages with each of the microcontroller contained in the lock unit and a supervisory control processor at the remote site.

The interface's control processor includes a first associated non-volatile random access memory into which interface-provisioning information may be downloaded from the supervisory site for controlling the operation of the interface and the respective external I/O devices served by the interface. Additional non-volatile memory units are incorporated into the interface to provide an associated lock unit that is coupled to the interface with expanded storage capability, for maintaining an extended record of lock unit access usage.

As a stand-alone device, the interface further includes voltage regulation circuitry which supplies the necessary voltage levels for the circuit components of the interface, and an internal real time clock, which is coupled to the control processor. The control mechanism for processor is operative to read the time of day provided by a real time clock, so that the interface may keep a record of usage of any I/O devices to which the interface is connected.

The interface also contains auxiliary ports, which provide direct connections to respective elements, such as input switch devices, and thereby allow the processor to directly read the closure state of input switches. A non-limiting example of such input switch connections include a connection to a push-button switch, which may be employed to provide auxiliary entry access separate from the insertion of

a key into the lock unit. The auxiliary ports also allow the user to selectively define and operate connections to input/output devices.

Auxiliary port connections include latching relays coupled to manually provisioned option switches, that allow the user to predefine the ability of either an associated lock unit, an associated I/O device, or the interface's processor to operate the latching relay unit, and thereby provide circuit path connections through relay closure contacts, and thus controllably and selectively completing circuit paths through the auxiliary ports. A bidirectional auxiliary port allows the processor to be interfaced with a further auxiliary device, such as a keypad, card reader, analog-to-digital converter, thermostat, etc. In addition, an auxiliary port may be coupled to a DIP switch to independently define the address of the interface when installed apart from a lock unit.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 diagrammatically illustrates an electronic lock and key system of the type described in the above referenced the '036 application, and incorporating an interface in accordance with the present invention; and

Figure 2 is a detailed circuit diagram of the interface 10 of Figure 1.

DETAILED DESCRIPTION

Before describing in detail the particular improved interface in accordance with the present invention, it should be observed that the present invention resides primarily in a novel structural combination of conventional signal processing and communication circuits and components and not in the particular detailed configurations thereof. Accordingly, the structure, control and arrangement of these conventional circuits and components have been illustrated in the drawings by readily understandable block diagrams which show only those specific details that are pertinent to the present invention, so as not to obscure the disclosure with structural details which will be readily apparent to those skilled in the art having the benefit of the description herein. Thus, the block diagram illustrations of the Figures do not necessarily represent the mechanical structural arrangement of the exemplary system, but are primarily intended to illustrate the major structural components of the system in a convenient functional grouping, whereby the present invention may be more readily understood.

Referring initially to Figure 1, an electronic lock and key system of the type described in the above referenced the '036 application, and incorporating an interface in accordance with the present invention, shown in detail in Figure 2, to be described, is diagrammatically illustrated as comprising an electronic lock and key system 1 containing a key 2 and a lock unit 3. Key 2 is configured to engage a key interface 4 and

communicate with lock unit 3, for operating an actuator device 5 (e.g. a solenoid that translates a dead bolt element 6 between lock and open positions). As noted above, and as described in detail in the '036 application, each of the key 2 and lock unit 3 contains on-board intelligence and associated memory that allows the respective micro-controllers within the lock unit and the key to be individually programmed. As described briefly above, lock unit 3 has its own internal power supply (battery), which supplies electrical power to both itself and key 2, so that for each access site where such a lock unit is installed, the lock unit may be operated as a stand alone device. Since the lock unit's key interface 4 is a two way communication port, it may be used to exchange lock interrogation and provisioning messages between the lock's internal control processor and an interrogation and programming device that is coupled to the keyway 4.

In addition, lock unit 3 has an auxiliary programmable input/output port 7, through which a pathway, such as a telephone line shown in broken lines 9, may be provided to a remote site 20 that allows the lock unit 3 to communicate with a central database installed at that site. This auxiliary capability allows the lock unit to be remotely provisioned (controlled and reprogrammed with information

received from the central database), as well as send information to site 20, so that the central database may maintain accurate and up-to-date records of the identity and accessing of multiple lock units that have been installed at a plurality of access locations.

In accordance with the present invention, rather than connect auxiliary port 7 of the electronic lock unit 3 directly to the supervisory site 20, an interface 10, shown in detail in Figure 2, is installed between the lock unit 3 and a communication link 23 to the remote site 20. Interface 10 has a first communications port 11, which is coupled, via a first digital data communications link 12, to the internal controller of lock unit 3. In order to communicate with remote supervisory site 20, interface 10 also includes a second communications port 21, which is arranged to be coupled via a second digital data communications link 23 to a supervisory control processor at the supervisory site 20.

More particularly, referring to the detailed diagram of Figure 2, the interface of the present invention is shown as comprising a first communications port, shown as a multi-bit terminal or jack 11, which is arranged to be coupled, via first digital data communications link 12, to the internal controller of electronic lock unit 3. Second communications port 21 is coupled to a digital communications transceiver, such as an RS 485 UART device, shown at 25, through which

interface 10 communicates with the remote site 20. Transceiver 25 is also preferably coupled with a stereo phone jack 28 to allow for DTMF signalling with an external modem device.

Interface 10 includes an interface control processor 31, which preferably comprises a commercially available microprocessor chip, such as a MC68HC705 chip manufactured by Motorola Inc, which is coupled to each of the first and second communications ports 11 and 21, and is operative to exchange messages with each of the micro-controller contained in the lock unit 3, and also a supervisory control processor at the supervisory remote site 20. Interface control processor 31 includes a first associated non-volatile random access memory (NVRAM) unit 33, which contains an operating systems routine, and interface-provisioning information downloaded from the remote control site 20, for controlling the operation of the interface and the respective external I/O devices served by the interface, as will be described.

Also coupled to the lock unit 163 via the first communications port 11 are additional (NVRAM) units 35 and 37, which provide the lock unit with expanded storage capability, for maintaining an extended record of lock unit access usage. Namely, as described in the above-referenced '036 application, the control software resident in the lock unit causes each occurrence of attempted access to the lock to be identified in terms of its time of day occurrence. By incorporating these

auxiliary memory units 35 and 37, the interface effectively augments the ability of the lock to keep a record of this information.

Similarly, in order to equip interface 10 with stand alone capability, it has its own voltage regulation circuitry which supplies the necessary voltage levels for the circuit components of the interface, and an internal real time clock, which is coupled to control processor 31. The resident control mechanism for processor 31 is operative to read the time of day provided by a real time clock 41, so that interface 10 may keep a record of usage of any I/O devices to which the interface is connected. For example, where the interface is coupled to monitor the operation of a push-button switch, for providing auxiliary entry access separate from the insertion of a key into a lock unit, the processor uses the real time clock to log such switch operation in the same manner that the internal micro-controller of a lock unit logs each key insertion.

The voltage regulation circuitry comprises respective twelve and five volt voltage regulators 43 and 45. Twelve volt regulator 43 receives its unregulated or coarse input voltage (e.g. in a range on the order of 12-24V) via a first auxiliary port, shown as a multi-pin terminal connector 51. This coarse input voltage is regulated to twelve volts and five volt outputs by voltage regulator circuits 43 and 45, respectively, for application to respective circuit components of the interface 10.

The stand alone interface of the present invention also includes at least one, and preferably more than one, auxiliary port, which is arranged to be coupled to a respective switch device, that is coupled in circuit with one or more associated auxiliary input or output devices external to the lock unit and the operation of which are not necessarily associated with the operation of the lock unit. As pointed out above, such devices include, but are not limited to, a push-button switch, surveillance camera, smoke detector, fire alarm, sprinkler system, etc.

More specifically, the interface 10 includes a second auxiliary, multi-input switch port 52, shown as containing a non-limiting example of four input switch terminals 56, 57, 58 and 59, which provide a direct connections to respective input switch devices, and thereby allow processor 31 to directly read the closure state the input switches. A non-limiting example of such input switch connections include a connection to a push-button switch, such as that mentioned above, which may be employed to provide auxiliary entry access separate from the insertion of a key into a lock unit.

The first auxiliary port 51 and a third auxiliary port, shown at 53, are configured to allow the user to selectively define and operate connections to input/output devices. Connection to first auxiliary port 51 includes a first latching relay unit 61, having a pair of normally open internal relay closure contacts, which are coupled in respective circuit paths 71 and 72 of port 51. First latching

relay unit 61 includes a pair of internal latching relays, control signals for which are coupled to terminals 83 and 84 of a first double pole, single throw option switch 91. A first pair of relay driver inputs to first option switch 91 are coupled via bipolar transistor-configured relay driver circuits 101 and 102, control inputs for which are coupled to links 111 and 112 from control processor 31. A second pair of relay driver inputs to first option switch 91 are coupled via links 121 and 122 from port 11 to the lock unit 3. First option switch 91 may be manually provisioned to predefine the ability of either an associated lock unit or the processor 31 to operate either or both of the internal latching relays of latching relay unit 61, so as to provide circuit path connections through either or both of the pair normally relay closure contacts, and thereby controllably and selectively complete circuit paths 71 and 72 of auxiliary port 51. Thus, auxiliary port 51 allows either the interface or the lock unit to control external switch contact closures.

In like manner, interface 10 includes a second latching relay unit 62, which also has a pair of normally open internal relay closure contacts, that are coupled in respective circuit paths 75 and 76 of third auxiliary port 53. Like latching relay unit 61, latching relay unit 62 includes a pair of internal latching relays, control signals for which are coupled to terminals 85 and 86 of a second double pole, single throw option switch 92. A pair of relay driver inputs to second option switch 92 are coupled via bipolar transistor-

configured relay driver circuits 105 and 106, control inputs for which are coupled to links 115 and 116 from control processor 31. A second pair of relay driver inputs to second option switch 92 are coupled via links 125 and 126 from third auxiliary port 53, to which external I/O devices are coupled. Second option switch 92 may be manually provisioned to predefine the ability of either an associated I/O device (e.g. external switch) or processor 31 to operate either or both of the internal latching relays of latching relay unit 62, providing provide circuit path connections through either or both of the pair normally relay closure contacts, and thereby controllably and selectively completing circuit paths 75 and 76 of third auxiliary port 53. A non-limiting example of the use of third auxiliary port 53 for this purpose is to couple the output of a smoke detector device to trigger an associated fire alarm unit, the operation of which is independent of the lock unit.

Also shown in Figure 2 is a fourth, bidirectional (eight-bit parallel) auxiliary port 87, through which processor 31 may be interfaced with a further auxiliary device, such as a keypad, card reader, analog-to-digital converter, thermostat, etc. A fifth auxiliary port 88 is coupled to (an eight bit) DIP (dual in-line package) switch 89, the operation of which may be used to independently define the address of interface 10, when installed apart from a lock unit 3. Auxiliary ports 87 and 88 are selectively coupled to processor 31 via a multiplexer 90.

As described previously, operation of the interface 10 is controlled by digital communication messages sourced via link 23 from the remote site 20. When connected to auxiliary programmable input/output port 7 of lock unit 3, the interface provides the site at which the lock unit is installed with expanded functionality, while still allowing the lock unit to communicate with the central database installed at that site. When the interface is initially installed, either in association with an attendant lock unit, or exclusive of a lock unit, it is interrogated by the supervisory controller at the remote site for identification and capability. As pointed out above, the identification of the interface unit may be manually set by DIP switch 89. Since no site access control software is initially installed, the remote site's processor performs all provisioning via link 23 and port 21. In this manner the attendant program for defining the operation of the interface is downloaded into NVRAM 33, so that processor 31 may operate the interface in accordance with this remotely sourced functionality.

Once the interface has been remotely provisioned, microprocessor 31 proceeds to execute the operational control program stored in memory 33. As explained above, as processor 31 executes control responses to I/O inputs to the interface, its maintains a real time record of each access, via real time clock 41, so that interface 10 may keep a record of usage of any I/O devices to which the interface is connected.

Through the auxiliary ports, processor 31 is able to read the closure state input switches, such as a push-button device that may be employed to provide auxiliary entry access separate from the insertion of a key into the lock unit served by the interface. Depending upon the settings of the option switch control inputs to the latching relay units 61 and 62, the first and third auxiliary ports 51 and 53 allow the lock unit, the processor, or an external device to establish circuit path closures to auxiliary I/O devices connected to the interface.

As will be appreciated from the foregoing description, the interface of the present invention is not only operative to remove the requirement that a supervisory remote site maintain an active communication link with each access entry unit on a full time basis, but is also able to transfer the supervisory control mechanism to the locale where most of the events involving the security system happen - at the lock. As a result, should there be a failure involving the supervisory site or the link between the lock and the site, the lock can continue to perform its intended function. The interface also enables the lock to be interrogated and provisioned from the remote site and provides for the execution of one or more auxiliary functions, either in conjunction with or exclusive of the operation of the lock, in association with the site at which the lock is located.

While I have shown and described an embodiment in accordance with the present invention, it is to be understood that the same is not limited thereto but is susceptible to numerous changes and modifications as known to a person skilled in the art, and I therefore do not wish to be limited to the details shown and described herein but intend to cover all such changes and modifications as are obvious to one of ordinary skill in the art.

WHAT IS CLAIMED:

1. An interface for an electronically controlled access device, said access device having a lock unit which is operative, in response to a key input, to controllably actuate an access mechanism, said lock unit having a controller and associated memory, said controller being capable of conducting communications with a communications device external to said lock unit, comprising:

a first communications port which is arranged to be coupled to said controller of said lock unit;

a second communications port which is arranged to be coupled to said communications device external to said lock unit; and

a interface control processor, coupled to said first and second communications ports and being operative to exchange messages between the controller of said lock unit and said communications device external to said lock unit.

2. An interface according to claim 1, further including at least one auxiliary port which is arranged to be coupled to at least one auxiliary input or output device external to said lock unit, said at least one auxiliary port being further coupled to supply an input signal to or receive a command signal from said interface control processor.

3. An interface according to claim 2, wherein said at least one auxiliary input or output device external to said lock unit includes a security monitoring device located in the vicinity of said electronically controlled access device, said security monitoring device being operative to monitor a prescribed condition in the vicinity of said electronically controlled access device and, in response to the occurrence of said prescribed condition, to supply an input signal to said interface control processor.

4. An interface according to claim 2, wherein said at least one auxiliary input or output device external to said lock unit includes an alarm device located in the vicinity of said electronically controlled access device, said alarm device being operative to generate an alarm signal in response to a command signal from said interface control processor.

5. An interface according to claim 1, wherein said interface control processor includes associated memory which is operative to store interface provisioning information supplied by way of said second communications port from said communications device external to said lock unit.

6. An interface according to claim 1, wherein said interface control processor is operative to supply lock provisioning signals via said first communications port to said controller of said lock unit, in accordance with a lock provisioning communication message received by way of said second communications port from said communications device external to said lock unit.

7. An interface according to claim 1, wherein said interface control processor is operative to interrogate said controller of said lock unit, in accordance with a lock interrogation message received by way of said second communications port from said communications device external to said lock unit, and to supply a response message containing information requested in said lock interrogation message to said communications device external to said lock unit.

8. An interface for an electronically controlled access device, said access device having a lock unit which is operative, in response to a key input, to controllably actuate an access mechanism, said lock unit having a controller and associated memory, said controller being capable of conducting communications with a communications device external to said lock unit, comprising:

a first communications port which is arranged to be coupled to said controller of said lock unit;

a second communications port which is arranged to be coupled to said communications device external to said lock unit;

a interface control processor, coupled to said first and second communications ports and being operative to exchange messages between the controller of said lock unit and said communications device external to said lock unit; and

a plurality of input/output ports arranged to be coupled to a plurality of input/output devices external to said lock unit, selected ones of said input/output ports being coupled to supply input signals to or receive command signals from said interface control processor, or an external device.

9. An interface according to claim 8, further including a first associated memory unit into which interface-provisioning information may be supplied from a remote control site for controlling the operation of the interface and the respective external I/O devices served by the interface.

10. An interface according to claim 8, further including additional memory units coupled to said first communications port and being operative to provide said lock unit with expanded storage capability, for maintaining an extended record of lock unit access usage.

11. An interface according to claim 8, further including voltage regulation circuitry which supplies voltage levels for the circuit components of the interface, and an internal real time clock, coupled to said control processor.

12. An interface according to claim 8, wherein said plurality of input/output ports include a first auxiliary, multi-input switch port which is configured to provide connections to respective input switch devices, and thereby allow said processor to directly read the closure state of said input switch devices.

13. An interface according to claim 8, wherein said plurality of input/output ports include second and third auxiliary ports configured to allow an interface user to selectively define and operate respective diverse types of input/output devices.

14. An interface according to claim 13, wherein said second auxiliary port includes a first latching relay unit, having a plurality of normally open relay closure contacts, which are coupled in respective circuit paths of said second auxiliary port, and wherein said first latching relay unit includes a plurality of latching relays, which are coupled in circuit to terminals of a first option switch, first inputs for which are coupled to said control processor, and second inputs for which are coupled to said lock unit, said first option switch being provisionable to predefine the ability of either said lock unit or said control processor to operate latching relays of said latching relay unit, and thereby provide circuit path connections through said relay contacts, to complete circuit paths of said second auxiliary port.

15. An interface according to claim 14, wherein said third auxiliary port includes a second latching relay unit, having a plurality of normally open relay closure contacts, which are coupled in respective circuit paths of said third auxiliary port, and wherein said second latching relay unit includes a plurality of latching relays, which are coupled in circuit to terminals of a second option switch, first inputs for which are coupled to said control processor, and second inputs for which are coupled to said third auxiliary port, said second option switch being provisionable to predefine the ability of either said control processor or a device external to said interface to operate latching relays of said second

latching relay unit, and thereby provide circuit path connections through said relay contacts, to complete circuit paths of said third auxiliary port independent of said lock unit.

16. An interface according to claim 14, wherein said third auxiliary port includes a latching relay unit, having a plurality of normally open relay closure contacts, which are coupled in respective circuit paths of said third auxiliary port, and wherein said latching relay unit includes a plurality of latching relays, which are coupled in circuit to terminals of an option switch, first inputs for which are coupled to said control processor, and second inputs for which are coupled to said third auxiliary port, said option switch being provisionable to predefine the ability of either said control processor or a device external to said interface to operate latching relays of said latching relay unit, and thereby provide circuit path connections through said relay contacts, to complete circuit paths of said third auxiliary port independent of said lock unit.

17. An interface according to claim 13, further including a fourth, bidirectional auxiliary port through which said processor is interfaced with a further auxiliary device, and a fifth auxiliary port coupled to a switch, the operation of which may be used to independently define the address of said interface when installed apart from said lock unit.

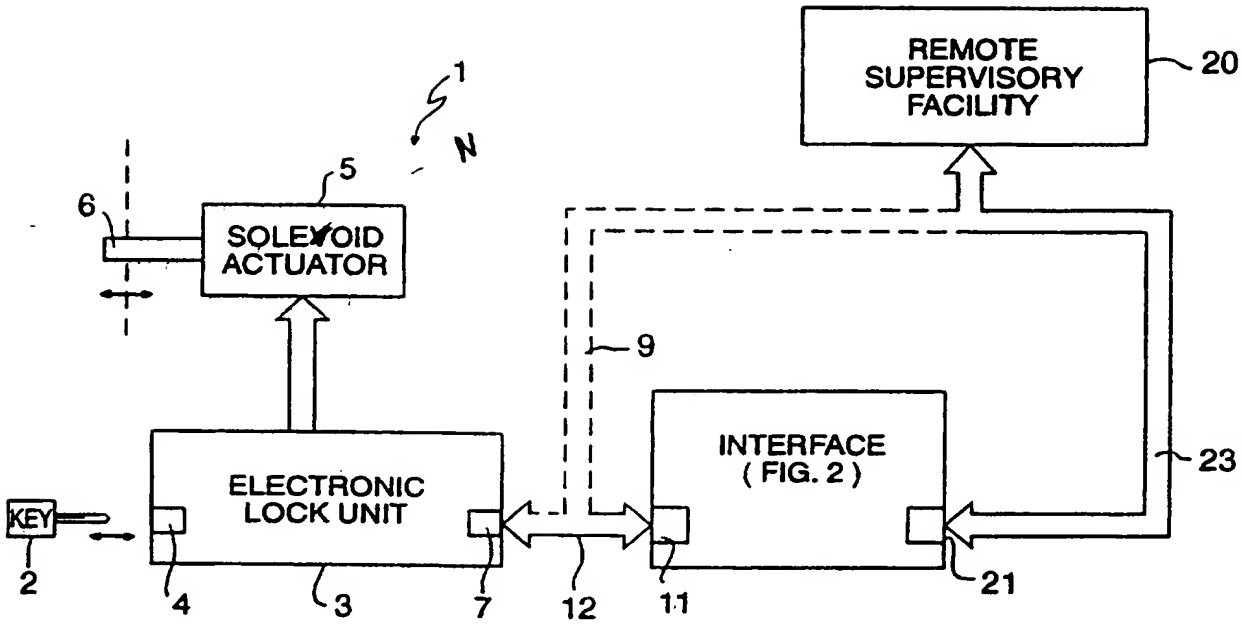
REMOTE SUPERVISORY FACILITY
20
1
N
5
6
SOLENOID ACTUATOR
9
INTERFACE (FIG. 2)
23
ELECTRONIC LOCK UNIT
KEY
2
4
3
7
12
11
21

FIGURE 1

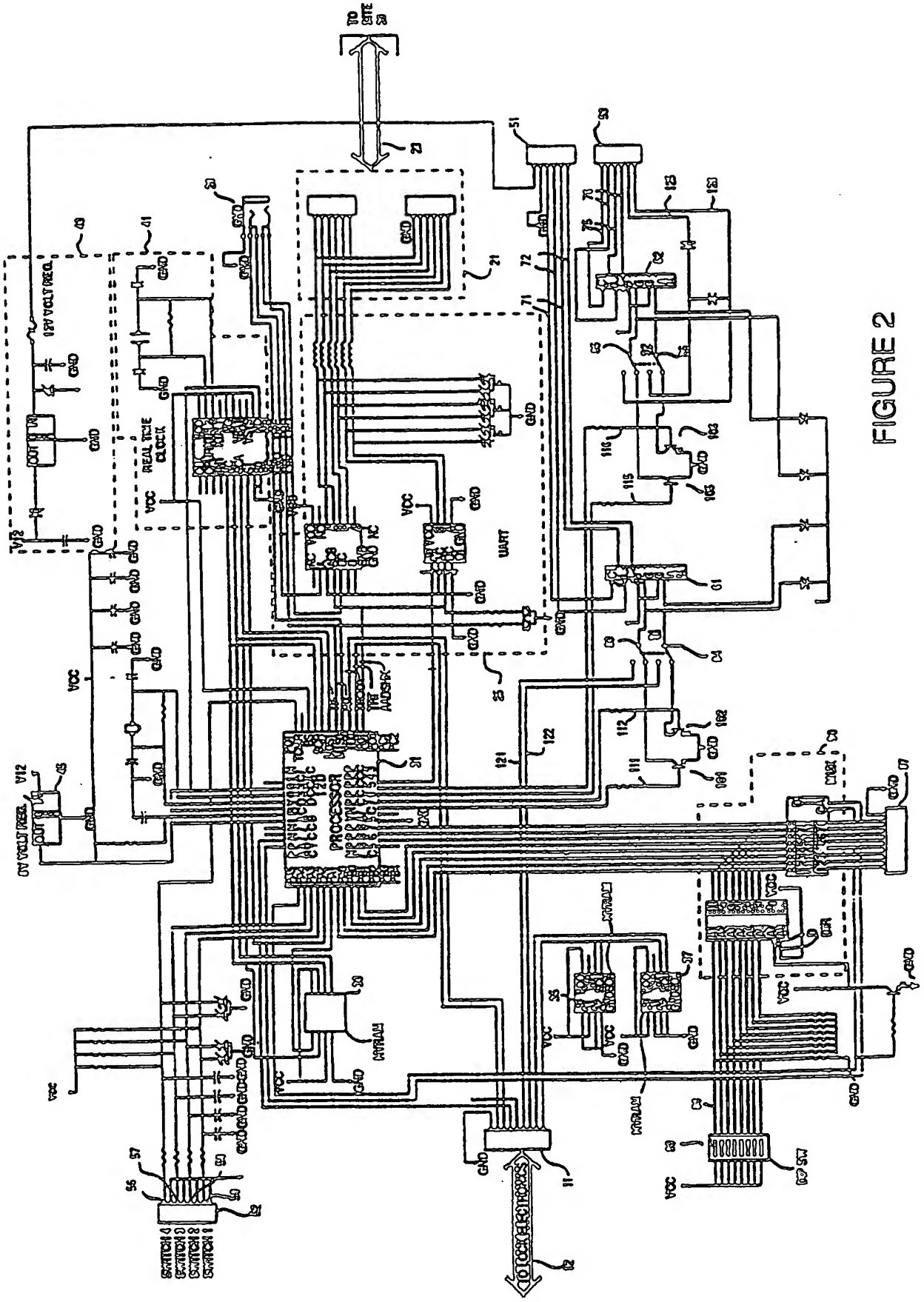
TO SITE
PROCESSOR
REAL TIME CLOCK
UART
VCC
GND
SWITCH 4
SWITCH 3
SWITCH 2
SWITCH 1

FIGURE 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/10315

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :G06F 7/04
US CL :340/825.310
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 340/825.310, 825.320, 825.340

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---- Y	US, A, 5,245,329 (GOKCEBAY) 14 September 1993, see the abstract, figures 1,3,4,5,7 and col. 10, lines 11-58.	1-6,8-11,17 ---------- 7,12-16
Y	US, A, 4,839,640 (OZER, ET AL.) 13 June 1989, see the abstract, figures 1-2, and column 3, line 10 to column 6, line 39.	7, 12-16
A	US, A, 4,415,893 (ROLAND, ET AL.) 15 November 1983, see the abstract, figures 1,2,16, and column 3, lines 10-41.	1,8

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
15 OCTOBER 1995	15 DEC 1995
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer EDWIN C. HOLLOWAY, III Telephone No. (703) 305-4900

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